

# Context-Dependent Memory and Mood

Erik Løhre



Master of Philosophy in Psychology,  
Cognitive Neuroscience

Department of Psychology

UNIVERSITETET I OSLO

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**Abstract**

This thesis examined the effects of affective state (mood) on context-dependent memory. In the so-called context-change paradigm, participants learn two lists of words, and their internal context is either changed or kept constant between the two lists. The usual finding in this paradigm is that participants remember fewer words from the first list, but more words from the second list when context is changed compared to when it is kept constant. To see whether these effects are influenced by affective state, participants from the normal student population were exposed to positive, neutral or negative affective pictures after an internal context-change procedure. Surprisingly, no effects of context on memory were found in any condition. A control experiment with the same internal context-change procedure, but using a neutral distraction task instead of a mood induction, again failed to replicate the usual effect of a change in context on memory. The question of whether affective states influence context-dependent memory is left open by these findings. Future studies investigating this phenomenon should take care to use context manipulations that induce clear and strong changes in context.

### **Introduction**

It is an embarrassing, but not uncommon, experience to meet a familiar person on the street, but being unable to remember who this person is or from where you know her. Later, when you encounter the same person in the place where you are used to seeing her, it all falls into place – “of course, it is Emma from my statistics class!”. This everyday experience can serve as an example of the influence of context on memory. Remembering the identity of your acquaintance is hard when the surrounding context is different from the context where she is normally encountered, but returning to the original context facilitates your memory.

Experimental evidence confirms that human episodic memory can be influenced by changes in context (Smith & Vela, 2001). If some material is learned in one context and then tested in another context, it is less well remembered than if learning and testing occurs in the same context. For instance, scuba divers who learnt lists of words either underwater or on land, remembered fewer words when they were tested in the other environment as compared to the same environment (Godden & Baddeley, 1975). The forgetting that occurs due to a change in context is often referred to as context-dependent forgetting. The other side of the coin is that context can act as a cue that improves memory. For instance, when environmental context is changed between learning and testing, it has been shown that a mental reinstatement of context will lead to better performance on a memory test (Smith, 1984).

Memory is also influenced by affective states, or moods. Two important mood/memory phenomena that have been quite extensively researched are mood-congruent and mood-dependent memory (Ellis & Moore, 1999). Mood-congruent memory refers to enhanced encoding and/or retrieval of material which is congruent to the current mood. This is for instance demonstrated by the fact that depressed patients retrieve less positive and more negative memories than control participants (Lemogne et al., 2006). Mood-dependent memory refers to mood acting as a contextual cue for memory, such that more material is remembered when the mood at retrieval matches the mood at encoding (Bower, Monteiro, & Gilligan, 1978; Eich & Metcalfe, 1989).

However, little is known about the interplay between context-dependent memory and mood. Can different moods influence cognition in such a way that normal effects of context on memory are enhanced, weakened, or otherwise changed? The goal of this thesis is to investigate this question. The answers to it might have significance for the understanding of basic interactions between mood and memory, and could also have practical implications. If, for instance, positive moods make people less vulnerable to context-dependent forgetting, it would be desirable to try to create a positive mood when eyewitnesses are questioned about

an event. A student preparing for an exam in an unfamiliar setting would probably also be interested in knowing whether the negative mood that is associated with exams for a lot of students, leads to greater or smaller effects of a context change than neutral mood.

### **Contextual influences on memory**

The influence of context on memory has been studied by psychologists for a long time. Smith & Vela (2001) cite Carr's (1925) studies of the effects of incidental environmental manipulations on maze running in rats as one early example. And context is still regarded as an important component in several current theoretical models of memory such as the temporal context model (TCM, Howard & Kahana, 2002) and the search of associative memory model (SAM, Mensink & Raaijmakers, 1988). But what exactly is meant by context?

According to Smith (2007): "Context, most generally defined, is that which surrounds." According to this broad definition, a wide range of sensory stimuli as well as internal states can act as contexts during cognitive processing, and many different types of contexts have been studied by psychologists at different times. One common feature of different types of contexts is that the context surrounds a central stimulus, although it varies how enmeshed contexts are with the focal stimulus. Another important point is that contexts are usually composed of many different elements that are changing at varying pace. A participant in a psychological experiment learning a list of words in a lab on the university can be used as an example. For the participant, the room where learning takes place, the color of the walls, the noise from a nearby construction site, but also his mood or his thoughts about an upcoming exam, all these elements that principally are not related to the learning of a list of words, could act as a part of the context in which the learning is taking place. During the experiment, some of these contextual elements might be constant (like the color of the walls), while other elements might be subject to gradual or sudden changes (like the construction noise or the participants mood).

The type of context that has been studied most extensively is probably environmental context. A lot of studies support the effect of physical surroundings on memory (Smith & Vela, 2001), although the effects are greater when the context manipulation is quite strong, such as in Godden & Baddeley's (1975) classic experiment with scuba divers underwater or on land. With weaker manipulations of environmental context (changing rooms between learning and testing) the effects of context on memory are sometimes not found at all (Fernandez & Glenberg, 1985; Saufley, Otaka, & Bavaresco, 1985). It is also worth noting

that while effects of context on memory are generally found when recall tests are used, they are usually not found when recognition tests are used (Smith, 1988). Some studies find an effect of context on recognition based on recollection but not on recognition based purely on familiarity (Gruppuso, Lindsay, & Masson, 2007; Macken, 2002), but overall, the effect is more stable in recall than in recognition memory.

Context effects of different internal states have also been investigated. For instance, participants who performed memory tasks either while sober or under the influence of alcohol and then were tested in the same or the different state 24 hours later, showed clear state-dependent effects – recall was better when subjects were intoxicated or sober during both learning and testing than when the state was changed (Goodwin, Powell, Bremer, Hoine, & Stern, 1969). This phenomenon of state-dependent memory has also been demonstrated for other drugs such as amphetamine and barbiturate (Eich, 1980). As already mentioned, mood can also act as context, and can be viewed as one particular example of state-dependency (Ellis & Moore, 1999). Recently, different imagination tasks, for instance asking people to imagine and describe that they are walking through their childhood home, have also been used to manipulate internal context (Sahakyan & Kelley, 2002).

Changes in context, whether environmental or internal, can have both detrimental and beneficial effects on memory. The detrimental effect of a context change on memory is demonstrated in studies showing that less of a material is remembered when there is a mismatch in context during learning and retrieval in comparison to when the context is left unchanged (Godden & Baddeley, 1975). If contextual elements are sampled during learning and used as cues during retrieval, it should be clear that a mismatch in context would lead to memorial costs (Smith & Vela, 2001). The beneficial effect of context changes for memory is for instance demonstrated in studies where several lists of words are learned in different contexts (multiple rooms) or in the same context (the same room). When the lists are learned in different contexts, free recall scores are better than when they are learned in the same context (Smith, 1982). The explanation for this beneficial effect of a context change is often said to be that the different lists are associated with the different contexts, and the contexts can then act as retrieval cues for each list. This reduces the interference that is present when all lists are associated with one context (Smith & Vela, 2001).

Effects of context on memory can also be found with other material than word lists and outside of the laboratory. For instance, context effects have been found for instrumental musicians performing memorized music (Mishra & Backlin, 2007), for students given a short answer or multiple choice test on a scientific article they recently read (Grant et al., 1998),

and for mock witnesses to a videotaped shop theft (Dando, Wilcock, & Milne, 2009). So, there should be no doubt that context-dependent memory can be an important phenomenon in real life as well as in the laboratory.

Quite recently, a paradigm that makes it possible to study the detrimental and beneficial effects of context on memory simultaneously was designed (Sahakyan & Kelley, 2002). In this context-change paradigm, participants are shown two lists of words. After List 1 is presented, participants are either cued to change their internal cognitive context (for instance through imagining and describing their childhood home) or are given a distraction task designed not to influence their internal cognitive context. Then, List 2 is presented, and participants are given a free recall test. The typical finding in the context-change paradigm is that participants in the context-change condition remember fewer words from List 1 (List 1 costs), but more words from List 2 (List 2 benefits) as compared to participants in the no-change condition. This finding has been replicated many times in student populations using different context-change tasks, for instance by instructing participants to imagine what they would do if they were invisible, by asking them to imagine their childhood home, by instructing them to think about autobiographical memories about a vacation, and even by giving participants the surprising task of wiping the computer screen and their hands (Delaney, Sahakyan, Kelley, & Zimmerman, 2010; Mulji & Bodner, 2010; Pastötter & Bäuml, 2007; Pastötter, Bäuml, & Hanslmayr, 2008; Sahakyan & Delaney, 2003; Sahakyan & Kelley, 2002). The effects of a change of context have also been studied in children, and List 1 costs have been found for first grade children (6-7 years) but not for kindergarteners (4-5 years) using an internal context manipulation (Aslan & Bäuml, 2008), while both List 1 costs and List 2 benefits were found for fourth graders (9-10 years) but not for younger children using an environmental context manipulation (Aslan, Samenieh, Staudigl, & Bäuml, 2010).

There are two main approaches to explain the costs and benefits of a context change in this paradigm. According to the one-factor retrieval-based account (Sahakyan & Kelley, 2002), the List 1 costs appear because there is a mismatch between the context at retrieval and the context during List 1 encoding. As context can act as a cue for retrieval, this mismatch lowers recall of List 1 items compared to when the context is kept constant. The List 2 benefits, on the other hand, are argued to arise because of an improved interference situation at test. A change of context binds each list to its own specific contextual cue. When there is no context change, there is a greater likelihood that both lists will be treated as a whole, and proactive interference from List 1 reduces the memory performance for List 2.



An alternative approach is the two-factor account, according to which the costs and benefits of a context change arise from different mechanisms (Sahakyan & Delaney, 2003). The List 1 costs are still argued to appear because of the mismatch in context during encoding and retrieval of List 1. The List 2 benefits, however, are said not to be due to the improved interference situation at test, but rather to participants more often using a deeper encoding strategy for List 2. This account is supported by an experiment showing that even though List 1 costs remain, List 2 benefits are abolished when the encoding strategy of the participants is controlled (Sahakyan & Delaney, 2003). Also, in a study using EEG to explore the oscillatory brain activity before and after a context change, a slight decrease in theta and alpha power was found during List 2 encoding after a context change, while an increase of theta and alpha power was found when there was no context change (Pastötter, et al., 2008). As alpha oscillations are usually linked with attention and theta oscillations are linked with memory load, the results were interpreted as showing that leaving context unchanged leads to a more divided encoding with inattention and increased memory load. It was argued that a change of context might abolish these effects, by resetting the encoding process such that attention is kept at a high level and memory load does not increase as much. Hence, these studies support the notion that List 1 costs and List 2 benefits are due to different mechanisms.

### **Context-dependent memory and directed forgetting**

The influence of context on memory is interesting in its own right. But in addition, studies on context-dependent memory are interesting because the results from the list-method directed forgetting paradigm have recently been explained with a context-change account (Sahakyan & Kelley, 2002). The list-method directed forgetting paradigm is used to study intentional forgetting, or in other words the voluntary forgetting of information. In this paradigm participants learn two lists of words. After List 1, the participants are either told to forget the first list, or to keep on remembering it. After presentation of List 2, a memory test for both of the lists is given. The usual results from this paradigm mirror the results from the context-change paradigm: participants show reduced memory for List 1 (List 1 costs) and enhanced memory for List 2 (List 2 benefits) after a forget cue as compared to a remember cue (MacLeod, 1998). Often, these results are said to be due to retrieval inhibition – the forget cue makes participants inhibit List 1 items, and the resulting decrease in proactive interference from List 1 items improves the memory for List 2 items (Geiselman, Bjork, & Fishman, 1983).

However, this inhibitory account of directed forgetting was challenged by Sahakyan and Kelley (2002). They argued instead that the forget cue leads participants to change their internal mental context, by thinking about something else than the first list of words. And indeed, they found highly similar results whether they used a forget cue or an internal context change procedure between the two lists. There are also other parallels between the two paradigms. For instance, similarly to the context-change paradigm, the costs and benefits of a forget cue are found quite consistently in free recall, but not in recognition (MacLeod, 1998), in both paradigms the effects are not observed using implicit memory tests (Basden, Basden, & Gargano, 1993; Parker, Gellatly, & Waterman, 1999), and List 2 encoding after the forget or context-change cue is necessary for the List 1 costs to occur in both paradigms (Pastötter & Bäuml, 2007).

However, when one compares the neural correlates of the two paradigms, there seems to be a divergence. In a directed forgetting experiment, EEG was used to measure the brain oscillations during List 2 encoding (Bäuml, Hanslmayr, Pastötter, & Klimesch, 2008). The results showed that the forget cue, as compared to the remember cue, led to an increase in upper alpha power, and a decrease in upper alpha phase coupling. The reduced phase coupling was found to be related to List 1 costs, and the increase in power was found to be related to List 2 benefits. The results were interpreted as showing that there is an active inhibitory mechanism that leads to “unbinding” of List 1 items and deactivation of retrieval routes to List 1 items. These results are largely different from the ones found in the EEG study of the context-change paradigm (Pastötter, et al., 2008), and gives some support to the retrieval inhibition account of directed forgetting.

So, this theoretical debate is not settled. On the one hand, the retrieval inhibition account of directed forgetting still has a strong standing in the field (Bäuml, 2008). On the other hand, as there are just two studies showing a divergence (Bäuml, et al., 2008; Pastötter, et al., 2008) but several studies showing parallels (see, for instance, Sahakyan & Kelley, 2002) between context-dependent memory and directed forgetting, the most parsimonious explanation for the directed forgetting findings is that they are due to an internal context change. One explanation that could perhaps reconcile these views is that the results in both paradigms are due to an internal context change, but that this context change is generated in an inhibitory fashion in the directed forgetting paradigm and in a non-inhibitory fashion in the context-change paradigm. But this is a speculation that so far lacks direct empirical evidence. Either way, these theoretical questions make it interesting to compare results from context-

change studies with directed forgetting studies, to see if one can find further parallels or alternatively divergence between the two paradigms.

### **Mood and memory**

In the early years of cognitive psychology, the focus was mainly on “pure” cognitive processes, and emotional influences on cognition were often neglected (Norman, 1980). However, this has changed during the last couple of decades, and there is now little doubt that cognitive and emotional processes can interact and influence each other. On the one hand, emotional stimuli has a processing advantage over neutral stimuli, and on the other hand, cognitive reinterpretation of emotional stimuli can reduce their impact (Pessoa, 2008). And not only emotional stimuli, but also affective states, or moods, can influence cognition. Moods, as summarized in a recent article (Mitchell & Phillips, 2007), can be defined as mild, relatively long-lasting affective states, with positive or negative valence, that provides a background to our everyday activities. They are distinguished from emotions by a lack of pronounced facial expressions and changes in autonomic activity, and unlike emotions, the reasons for why we are in a particular mood can often be unclear. Interestingly, it has also been proposed that while the primary function of emotion is to modulate or bias action, the primary function of mood is to modulate or bias cognition (Davidson, 1994).

One well-established research finding is that moods can influence the judgments people make. Generally, positive moods lead to more positive and negative moods to more negative evaluations of objects, people, or events (Clore & Huntsinger, 2007). More to the point, normal, day-to-day variations in moods can also influence memory. For instance, it has been shown that negative induced mood can reduce the false memory effect in the Deese-Roediger-McDermott paradigm (Storbeck & Clore, 2005), and that retrieval-induced forgetting (the fact that repeated retrieval of a subset of previously studied material can cause forgetting of non-retrieved related events) can be abolished in negative, but not positive induced mood (Bäuml & Kuhbandner, 2007). Recently it has also been demonstrated that mood can influence directed forgetting (Bäuml & Kuhbandner, 2009). In this study, positive, neutral or negative pictures were shown to the participants after they received the forget or the remember cue for List 1. Following encoding of List 2, the recall test showed that no List 1 costs were present for participants in the positive mood condition, while participants in the negative and neutral mood conditions showed normal List 1 costs. But why does mood influence cognition in these ways?

The so-called affect-as-information hypothesis (Clore & Huntsinger, 2007) is one approach to explaining how moods influence cognition. According to this approach, people who are in a happy mood engage in global, category-level, relational processing, while they engage in local, item-level, stimulus-specific processing when they are in a sad mood. For instance, in one study participants were asked to rate whether a target figure was most similar to a figure that matched its global features or a figure that matched its local features (Gasper & Clore, 2002). It was found that participants induced to a negative mood were more likely to focus on the local features, whereas participants induced to a positive mood were more likely to focus on global features. Positive and negative moods are proposed to have these different effects because moods can be seen as instances of positive and negative situations, and over a long period of learning, organisms acquire different processing styles in these situations (Fiedler, 2001). Negative situations often require avoidance and vigilance, they signal that something is wrong, and item-level, stimulus-specific processing is well-suited to the needs in such situations. Positive situations, on the other hand, allow for exploration and curiosity, and are thus associated with global, relational processing.

The affect-as-information hypothesis has been quite successful in explaining influences of affective states on judgments (Clore & Huntsinger, 2007) and on executive function (Mitchell & Phillips, 2007), and can also be used to explain the effects of mood on memory in the studies mentioned above. Both false memories in the Deese-Roediger-McDermott paradigm and retrieval-induced forgetting is supposed to be promoted by relational processing, and hence, inhibited by item-specific processing (Clore & Huntsinger, 2007). If negative mood leads to more item-specific processing, it is then reasonable that negative induced mood seems to reduce the tendency for false memories (Storbeck & Clore, 2005) and to abolish retrieval-induced forgetting (Bäuml & Kuhbandner, 2007). The effect of positive mood on directed forgetting (Bäuml & Kuhbandner, 2009) can also be explained in a similar fashion. In the positive mood condition, a global, relational processing style could be used by participants during List 2 encoding. The widespread associative networks that are activated during positive moods could then reactivate List 1 items even after a forget cue. In this way, reactivation of List 1 items could release them from inhibition or reinstate the List 1 context, eliminating directed forgetting.

According to the affect-as-information hypothesis, mood influences cognitive processing (and hence, memory) in quite specific ways. Another approach to the influence of mood on memory is seen in the previously mentioned literature on mood-dependent memory (Ellis & Moore, 1999). According to this view, mood acts as a context for encoding and/or

retrieval. One of the most well-known studies on mood-dependent memory (Bower, et al., 1978) used a procedure that resembles the one used in the context-change paradigm. Participants learned two lists of words, one while induced to a happy mood, and one while induced to a sad mood. A recall test of both lists was then given while participants were induced to either a happy or a sad mood, and performance was much better when the encoding and recall moods matched than when they mismatched. Although the robustness of this effect has been questioned, there is reason to believe that in some cases, mood can act as a powerful contextual cue.

In connection with context-dependent memory as studied in the context-change paradigm, it might then be speculated that mood could have one out of two possible effects. Either, in line with studies on mood-dependent memory (Ellis & Moore, 1999), mood could act first and foremost as a context. This could mean that a change of mood (say, from neutral to positive or negative mood) between List 1 and List 2 could lead to List 1 costs and List 2 benefits. Alternatively, mood might be less important as context, influencing cognitive processing in the more specific ways suggested in the affect-as-information approach (Clore & Huntsinger, 2007). This could for instance mean that being induced to a positive mood after List 1 could lead to a global processing style that reactivates List 1 items and reinstates the List 1 context, thus decreasing the context-dependent costs and benefits for positive mood.

### **The present experiment**

A thorough literature search indicates that this is the first study to investigate the interaction between context-dependent memory and mood. From both a theoretical and a practical point of view, it would be interesting to see if the combination of an internal context change with a mood induction procedure could influence the normal results in the context-change paradigm. Theoretically, the contextual account of the directed forgetting effect would be strengthened if a similar effect of mood was found in the context-change paradigm as in the directed forgetting paradigm, while it would be weakened if mood has a different effect on context-dependent than on directed forgetting. Another interesting theoretical aspect is whether mood influences cognitive processing in specific ways, in line with the affect-as-information hypothesis, or whether more general influences of mood as context will be found. Practically, if for instance negative mood decreases context-dependent costs and benefits, this would be interesting to know when questioning eyewitnesses. If people are less vulnerable to context effects in a negative mood, this is an advantage when they are interrogated about dramatic events that might depress their moods. And of course, it would also have practical

implications if positive mood influences context-dependent memory. For example, if positive mood leads to less context-dependent costs, students should try to do as much as possible to be in a positive mood when performing an exam in an unfamiliar location.

In Experiment 1, participants learnt two lists of words, and were exposed to an internal context-change task or a distraction task directly after List 1. Next, they were shown affective pictures of positive, neutral or negative valence before learning List 2. After a distraction task, a recall test for both lists followed.

It was hypothesized that normal effects of context on memory would be seen in the neutral mood condition. The neutral pictures should not influence cognitive processing, nor were they expected to lead to a change in internal context, and the neutral mood condition could therefore be regarded as a replication of other context-dependent memory studies with a minor variation in procedure. This means that it was expected that the context-change task would impair recall of List 1 words but improve recall of List 2 words as compared to the no-change task in the neutral mood condition.

Regarding the effects of positive and negative mood, there were several possibilities. First, mood could have a similar effect in the context-change as in the directed forgetting paradigm (Bäuml & Kuhbandner, 2009). This would mean that normal context-dependent costs would be apparent in the negative mood condition, while diminished or abolished context-dependent costs would be present in the positive mood condition. The widespread associative networks which are active in positive mood could reactivate the List 1 items and thus reinstate the original context during learning of List 2.

Second, if the mechanism behind directed forgetting is retrieval inhibition rather than a (non-inhibitory) context change, it might well be that mood could have other effects in the context-change paradigm. For instance, positive mood might lead participants to focus on global features, and negative mood might lead to a focus on local features (Gasper & Clore, 2002). In the context-change paradigm, rather than reactivating List 1 items, positive mood could then possibly induce a global processing of contextual elements during List 2 encoding. This could increase the influence of context on memory, and enhance context-dependent costs and benefits. Similarly, negative mood might lead to a more local, item-specific processing style during List 2 encoding. This could decrease the influence of context on memory, and could diminish or perhaps even abolish normal context-dependent costs and benefits.

Third, it could also be speculated that the results would show effects of moods as context (Ellis & Moore, 1999). As there is a mood induction between List 1 and List 2 in both the context-change and the no-change condition, this would mean that there would be a

change in context for participants in both context conditions. Hence, no effect of the context change would be observed in the positive and negative groups. However, these possibilities regarding the effects of mood should be seen as speculations rather than hypotheses.

## **Experiment 1**

### **Method**

#### **Participants**

72 students (63 females, 9 males) at the University of Regensburg with German as their mother tongue participated in the experiment. Ages ranged from 19 to 37 years ( $M = 21.74$ ,  $SD = 3.86$ ). Participants were recruited during lectures or through posters on campus, and received course credit for their participation. The experiment was approved by the ethical committee at the University of Regensburg.

#### **Design**

The study used a  $2 \times 3 \times 2$  mixed design, with order (context-change first, no-change first) and mood (positive, neutral, negative) as between-subjects factors, and context (context-change, no-change) as within-subjects factor. Each participant was randomly assigned to one of two orders and one of three mood conditions, and experienced both of the two context conditions. The dependent variable was the proportion of words remembered from each list.

#### **Materials**

**Words:** 4 word lists of 20 words each were constructed for the experiment. The words were emotionally neutral German nouns of medium frequency drawn from the CELEX database (Baayen, Piepenbrock, & van Rijn, 1995) using the WordGen 1.0 software toolbox (Duyck, Desmet, Verbeke, & Brysbaert, 2004). The word length was between 4 and 7 letters ( $M = 5.44$ ,  $SD = 1.11$ ), and across lists, the words were matched on frequency and word length. Each list was used equally often in each experimental condition (context-change, no-change) and served equally often as the list presented first or second in each condition. The original word lists with English translations are found in the appendix.

**Pictures:** 60 pictures for each of the mood conditions were selected from the international affective picture system (IAPS) database (Lang, Bradley, & Cuthbert, 2008), a database of affective color pictures with ratings for valence and arousal. From these pictures, two sets of 30 pictures were created. Each set was used equally often in the first and second

part of the experiment and was used equally often in each experimental condition (context-change, no-change). One way ANOVAs with the between factors of set (set 1, set 2) and mood (positive, neutral, negative) showed no effect of set on valence or arousal, both  $F$ 's < 1, but a significant effect of mood on both valence (positive,  $M = 7.58$ ,  $SD = .37$ , neutral,  $M = 4.96$ ,  $SD = .32$ , negative,  $M = 2.66$ ,  $SD = .65$ ),  $F(2,174) = 1602.21$ ,  $p < .001$ ,  $\eta^2 = .95$ , and arousal (positive,  $M = 5.14$ ,  $SD = .98$ , neutral,  $M = 3.21$ ,  $SD = .75$ , negative,  $M = 5.44$ ,  $SD = .89$ ),  $F(2,174) = 115.89$ ,  $p < .001$ ,  $\eta^2 = .56$ . Independent sample t-tests established that the valence scores were significantly different between the mood groups (all  $p$ 's < .001), and while the arousal scores did not differ significantly for the positive and negative group,  $t(118) = 1.74$ ,  $p = .09$ , both positive and negative pictures differed from neutral pictures, positive vs. neutral,  $t(118) = 12.14$ ,  $p < .001$ , negative vs. neutral,  $t(118) = 14.78$ ,  $p < .001$ .

**Positive and Negative Affect Schedule (PANAS).** To assess the usual affective state of the participants, a German version of the Positive and Negative Affect Schedule, PANAS (Watson, Clark, & Tellegen, 1988), was administered. The PANAS consists of 10 positive and 10 negative adjectives describing common emotional experiences (like “nervous”, “interested” or “proud”), and separate scores for positive affect (PA) and negative affect (NA) can be calculated. The participants were told to write a number between 1 and 5 to describe how often they usually experience the feeling described by the adjective, 1 meaning not at all, 5 meaning very often. The PANAS is reported to have acceptably high reliability, with Cronbach's  $\alpha$  over .85 for both PA and NA (Crawford & Henry, 2004).

**The Affect Grid (Russell, Weiss, & Mendelsohn, 1989).** This scale was used to check the effectiveness of the mood manipulation, and consists of a grid of 9 x 9 squares. The vertical dimension of the Affect Grid represents the degree of arousal, on a scale from 1 (extremely low arousal) to 9 (extremely high arousal). The horizontal dimension represents the degree of pleasantness, on a scale from 1 (extremely negative feeling) to 9 (extremely positive feeling). The participants were told to make a single cross anywhere in the grid to describe the way they were feeling at that moment, and an arousal and a pleasantness score was calculated from the position of this cross. As the Affect Grid is a single-item scale, reporting internal consistency is not possible. However, strong convergent, discriminant and construct validity has been found for the Affect Grid, which justifies its use in the assessment of mood states (Russell, et al., 1989).



## Procedure

The participants were tested individually by the same experimenter in the same room, using the same computer. E-Prime 1.2 was used to construct the experiment and to present it to the participants.

Participants were first given the PANAS questionnaire, which was used to assess their usual affective state. Next, participants were informed about the general nature of the experiment. They were told they would be shown lists of words, and that they were supposed to remember these words for a later test. It was also explained that some images would be shown during the experiment. It was specified that these images were not a part of the memory task, but were simply to be attended while presented. Each participant was randomly assigned to one of the three mood conditions (positive, neutral, negative) and one of the two order conditions (context-change first, no-change first). A schematic depiction of the experimental procedure is shown in Figure 1.

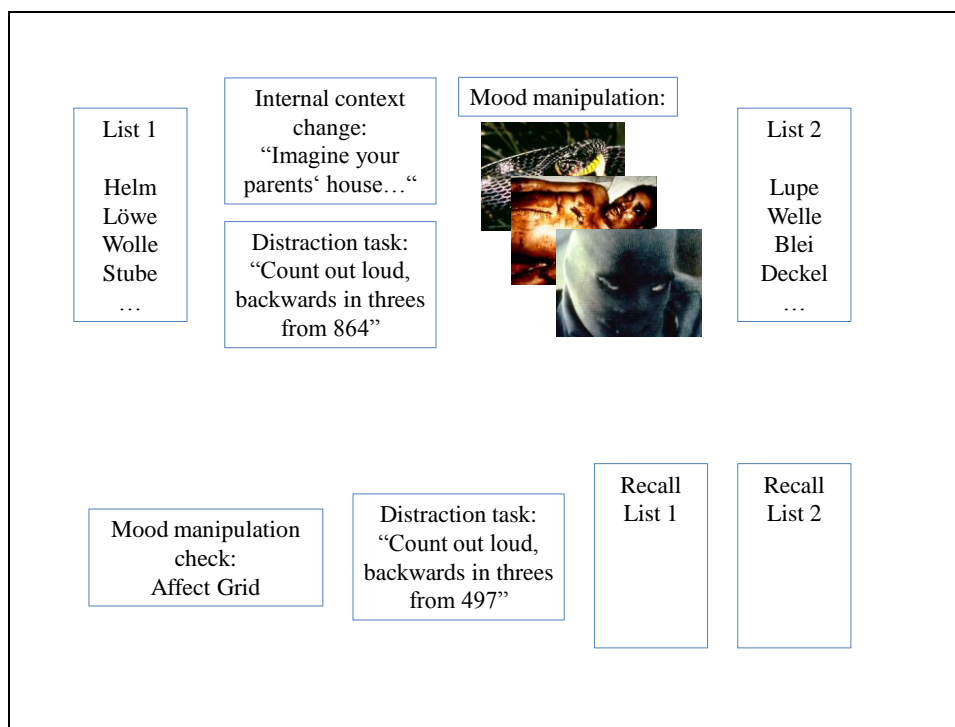


Figure 1. The experimental procedure

In the encoding phases, the 20 words from one of the four word lists were presented in a random order in the center of the computer screen. Each word was presented for 2000 ms, preceded by a fixation cross with a random duration between 1950 and 2050 ms<sup>1</sup>. After the

<sup>1</sup> The presentation times for the words and the fixation crosses were chosen because the same parameters were used in a similar experiment using EEG run in the same lab. Using the same parameters in this experiment allows more direct comparison of the behavioral results from the experiments.

encoding of List 1, the context-change task or a distraction task followed. For the context change, participants were told to make a “mental time-travel” to their childhood, and to describe the house or the apartment where they grew up to the experimenter.

The following instructions were used for the context-change task:

“Now, I want you to do a brief psychological task. I would like to hear a story from your childhood, about the house or the apartment where you grew up. So, for the next 45 seconds, I would like you to imagine your parents’ house, and that you describe to me all the details that you can remember. What did your room look like, who lived in the house, how were the surroundings, and so on.”

The instructions were given orally by the experimenter, and as soon as participants understood the instructions, the 45 second context-change task was started. In the no-change condition, participants were instead told to count out loud backwards in threes from a three digit number. This distraction task also lasted 45 seconds.

In the mood induction phase, 30 pictures were presented to the participants. The pictures were positive, neutral or negative, depending on which mood condition the participant was in. Each image was presented for 500 ms, and was preceded by a fixation cross with a random duration between 1450 and 1550 ms<sup>2</sup>.

After the encoding of List 2, participants were asked to indicate their affective state at the moment. The Affect Grid was used for this purpose.

To control for recency effects, participants were then asked to count out loud backwards in threes from a three digit number for 45 seconds. After this distraction task, a free-recall test was administered. Participants were given a sheet of paper, and were told to write down as many words as they could remember with a time limit of 90 seconds for each of the lists. It was decided to focus on the List 1 costs in this thesis, and therefore List 1 was always tested first.

After the recall test, there was a short break of about 2 minutes, where the experimenter made small talk with the participant. Then the experimental procedure was repeated, with the exception that the participants who had started with the context-change condition now experienced the no-change condition, and vice versa. After participants had experienced both conditions they were debriefed and the purpose of the experiment was briefly explained to them.

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<sup>2</sup> Again, the presentation times for the pictures and the fixation crosses were chosen to allow comparison with the results from a similar experiment run in the same lab.

## Results

### PANAS scores

The PA (positive affect) and NA (negative affect) score from the PANAS was calculated for each person. Separate one-way ANOVAs showed that there were no significant differences between the mood groups in mean PA scores (positive,  $M = 36.33$ ,  $SD = 3.19$ , neutral,  $M = 35.54$ ,  $SD = 5.05$ , negative,  $M = 36.21$ ,  $SD = 3.27$ ),  $F(2,69) < 1$ , or in mean NA scores (positive,  $M = 23.67$ ,  $SD = 3.81$ , neutral,  $M = 22.67$ ,  $SD = 4.64$ , negative,  $M = 25.13$ ,  $SD = 4.48$ ),  $F(2,69) = 1.96$ ,  $p = .15$ ,  $\eta^2 = .05$ .

### Mood manipulation check

As each subject filled out the Affect Grid questionnaire two times during the experiment, there were two pleasantness scores and two arousal scores for each subject. First, it was established through separate one-way repeated measures ANOVAs that the scores from each part of the experiment did not differ significantly, both  $F$ 's  $< 1$ , and then average pleasantness and arousal scores were calculated for each subject. Separate one-way ANOVAs showed that there were significant differences between the mood groups in the average pleasantness scores (positive,  $M = 6.46$ ,  $SD = 1.13$ , neutral,  $M = 6.50$ ,  $SD = .93$ , negative,  $M = 4.52$ ,  $SD = 1.38$ ),  $F(2,69) = 22.72$ ,  $p < .001$ ,  $\eta^2 = .40$ , while no significant differences were found for the average arousal scores (positive,  $M = 6.23$ ,  $SD = 1.23$ , neutral,  $M = 6.04$ ,  $SD = 1.02$ , negative,  $M = 6.35$ ,  $SD = 1.32$ ),  $F(2,69) < 1$ . Independent samples t-tests revealed that pleasantness scores did not differ significantly between positive and neutral moods,  $t(46) = .14$ ,  $p = .89$ , while both positive and neutral moods differed significantly from negative mood, positive vs. negative,  $t(46) = 5.32$ ,  $p < .001$ , neutral vs. negative,  $t(46) = 5.82$ ,  $p < .001$ .

### Recall data

The proportion of correctly recalled words was calculated for each list. A strict scoring criterion was used, and only words that were identical or were plurals or obvious misspellings of the original words were scored as correct. For instance, for the original word "Stube", the plural form "Stuben" and the misspelling "Stubhe" were scored as correct, while the synonym "Zimmer" was scored as incorrect. In line with previous studies in the same paradigm, List 1 and List 2 recall was analyzed separately. The recall rates for List 1 and List 2 are presented in tables 1 and 2 (all tables are found in the appendix).

**List 1 recall.** A 2x3 mixed ANOVA was carried out with context (context-change, no-change) as within-subjects factor and mood (positive, neutral, negative) as between-subjects

factor. No significant main effects of context,  $F(1,69) < 1$ , or of mood,  $F(2,69) = 1.37$ ,  $p = .26$ ,  $\eta^2 = .04$ , on List 1 recall were found, nor was any significant interaction between context and mood,  $F(2,69) = 2.11$ ,  $p = .13$ ,  $\eta^2 = .06$ .

**List 2 recall.** A 2x3 mixed ANOVA with context (context-change, no-change) as within-subjects factor and mood (positive, neutral, negative) as between-subjects factor for List 2 recall revealed no significant main effects of context or of mood, both  $F$ 's  $< 1$ . No significant interaction between context and mood were found for the List 2 recall results,  $F(2,69) = 1.32$ ,  $p = .28$ ,  $\eta^2 = .04$ .

**Intrusion errors.** The amount of intrusion errors (List 2 words recalled during List 1 recall, or List 1 words recalled during List 2 recall) was also recorded. The mean amount of intrusion errors was consistently below 5%. Separate 2x3 mixed ANOVAs with context (context-change, no-change) as within-subjects factor and mood (positive, neutral, negative) as between-subjects factor showed that List 2 intrusions during List 1 recall did not vary with context or mood, both  $F$ 's  $< 1$ , nor did List 1 intrusions during List 2 recall vary with context,  $F(1,69) = 1.16$ ,  $p = .29$ ,  $\eta^2 = .02$ , or with mood,  $F(2,69) < 1$ .

**Order effects.** To investigate possible order effects, two mixed ANOVAs were carried out on List 1 and List 2 recall separately, with context (context-change, no-change) as within-subjects factor and mood (positive, neutral, negative) and order (context-change first, no-change first) as between subject factors. A significant interaction between context and order was found for List 1 recall,  $F(1,66) = 20.55$ ,  $p < .001$ ,  $\eta^2 = .22$ , as well as for List 2 recall,  $F(1,66) = 20.64$ ,  $p < .001$ ,  $\eta^2 = .22$ . Also, an interaction between order and mood approaching significance was found for List 1 recall,  $F(2,66) = 2.92$ ,  $p = .06$ ,  $\eta^2 = .08$ . No other significant effects were found. The recall rates for List 1 describing the interaction between order and mood are presented in tables 3 and 4. The recall rates describing the interaction between context and order for List 1 and List 2 are presented in tables 5 and 6.

To investigate the order/mood interaction for List 1, separate paired sample t-tests for each order were performed for each mood. For the context-change first order participants remembered more List 1 words in the no-change condition than in the context-change condition, in the positive,  $t(11) = 2.57$ ,  $p < .05$ , but not in the neutral,  $t(11) = .75$ ,  $p = .46$ , or the negative mood group,  $t(11) = 1.42$ ,  $p = .18$ . For the no-change first order participants remembered more List 1 words in the context-change than in the no-change condition in the neutral,  $t(11) = 3.73$ ,  $p < .005$ , and negative,  $t(11) = 2.28$ ,  $p < .05$ , but not in the positive mood group,  $t(11) = .66$ ,  $p = .52$ .

Next, to interpret the interaction between context and order, the List 1 results were collapsed across the different mood groups, and separate paired sample t-tests were performed for each order. For the context-change first order, it was found that participants remembered more List 1 words in the no-change condition ( $M = .54$ ,  $SD = .23$ ) than in the context-change condition ( $M = .47$ ,  $SD = .22$ ),  $t(35) = 2.54$ ,  $p < .05$ . For the no-change first order, the opposite pattern was found: participants remembered more List 1 words in the context-change ( $M = .57$ ,  $SD = .19$ ) than in the no-change condition ( $M = .46$ ,  $SD = .19$ ),  $t(35) = 3.75$ ,  $p < .01$ . So, when the List 1 results were analyzed independent of mood, participants always remembered more words in what was for them the second part of the experiment.

For List 2, results were collapsed across the mood groups, and separate paired sample t-tests for each order showed the same pattern as List 1 when results were analyzed independent of mood. That is, for the context-change first order, participants remembered more List 2 words in the no-change condition ( $M = .54$ ,  $SD = .27$ ) than in the context-change condition ( $M = .45$ ,  $SD = .23$ ),  $t(35) = 2.34$ ,  $p < .05$ , and for the no-change first order, participants remembered more List 2 words in the context-change ( $M = .56$ ,  $SD = .23$ ) than in the no-change condition ( $M = .42$ ,  $SD = .24$ ),  $t(35) = 4.07$ ,  $p < .001$ .

So, the interactions between order and context reflected that participants always remembered more words from both List 1 and List 2 in the second part of the experiment. That is, those participants who started with the context-change condition remembered more words in the no-change condition, while those participants who started with the no-change condition remembered more words from the context-change condition.

### Discussion

Surprisingly, no effects of either context or mood on the percentage of words recalled were found. This could indicate that either the context manipulation or the mood manipulation, or both, were not functioning as they were supposed to do. Instead, significant interactions between order and context were found, indicating that participants always remembered more in the second part of the experiment. This could possibly be interpreted as a learning effect, that is, that participants got more familiar with the memory task, and thus showed a better performance during their second “try”. The interaction between order and mood for List 1 reflected a quite complex pattern of results, which will be discussed later.

One possibility that emerged to explain the lack of context effects was that the presentation of pictures between List 1 and List 2 in itself induced a context change for the participants. As the mood induction pictures are shown in both the context-change and the no-

change condition, it then might be that the context was changed in the no-change condition as well. If this reasoning is correct, the no-change condition is not a good control condition, and no List 1 costs or List 2 benefits would be revealed by comparing the two context conditions. To investigate this possibility, a control experiment was designed. In this experiment the pictures were removed and were substituted with an additional distraction task. The experiment could then be seen as a replication of the standard context-change paradigm, the only difference being the added short distraction task between List 1 and List 2 encoding. Thus, the standard effects of a context change (List 1 costs and List 2 benefits) were expected in Experiment 2.

## **Experiment 2**

### **Method**

#### **Participants**

24 students (16 females, 8 males) at the University of Regensburg with German as their mother tongue participated in the experiment. Ages ranged from 22 to 28 years ( $M = 23.75$ ,  $SD = 1.75$ ). Participants were recruited through posters on campus and during lectures and received 5 € for their participation. The experiment was approved by the ethical committee at the University of Regensburg.

#### **Materials**

The same word lists and mood measurement scales were used in this experiment as in the first experiment. No pictures were used in Experiment 2.

#### **Design**

The study used a 2x2 mixed design, with order (context-change first, no-change first) as between-subjects factor and context (context-change, no-change) as within-subjects factor. Each participant was randomly assigned to one of the two orders, and experienced both of the two context conditions. The dependent variable was the proportion of words remembered from each list.

#### **Procedure**

The experimental procedure in Experiment 2 was identical to the procedure in Experiment 1, with the exception of the mood induction. In both the context-change and the

no-change condition, participants were given an additional distraction task (backwards counting in threes from a three digit number) instead of being shown the mood induction pictures. The duration of the distraction task was 60 seconds, which corresponds to the duration of the mood induction in Experiment 1. A schematic depiction of the experimental procedure in Experiment 2 is shown in Figure 2.

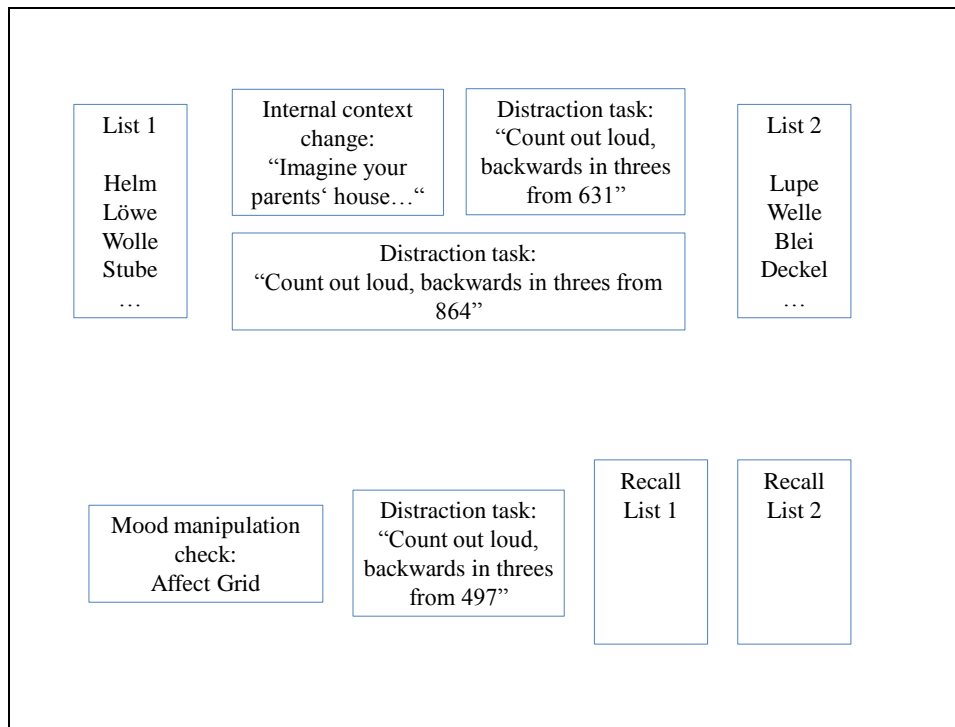


Figure 2. The experimental procedure in Experiment 2.

## Results

### PANAS scores

In Experiment 2, a mean PA score of 36.88 ( $SD = 3.44$ ) and a mean NA score of 23.46 ( $SD = 4.60$ ) was found. These scores were not significantly different from the scores of the three groups in the first experiment, as established with separate one-way ANOVAs, for the PA scores,  $F(3,92) < 1$ , for the NA scores,  $F(3,92) = 1.31$ ,  $p = .28$ ,  $\eta^2 = .04$ .

### Mood manipulation check

Again, separate one-way repeated measures ANOVAs showed that the pleasantness and arousal scores on the Affect Grid from the two parts of the experiments did not differ significantly from each other, both  $F$ 's  $< 1$ , and average scores were calculated. The average pleasantness score was 6.40 ( $SD = 1.10$ ) and the average arousal score was 6.40 ( $SD = .98$ ). When compared with the first experiment through separate one-way ANOVAs, significant

differences were found based on the average pleasantness scores,  $F(3,92) = 17.08, p < .001, \eta^2 = .36$ , while no significant differences were found for the average arousal scores,  $F(3,92) < 1$ . Independent samples t-tests revealed that the pleasantness score in Experiment 2 differed significantly from the score in the negative mood group,  $t(46) = 5.22, p < .001$ , while no significant differences with the positive,  $t(46) = .20, p = .85$ , or the neutral,  $t(46) = .36, p = .72$ , mood groups were found.

### Recall data

The same strict scoring criterion as in Experiment 1 was used when calculating the proportion of correctly recalled words for each list in Experiment 2. The recall rates for List 1 and List 2 are presented in table 7.

**List 1 recall.** Analyzing the results from Experiment 2 separately showed no effect of context (context-change, no-change) on the proportion of correctly recalled words for List 1,  $F(1,23) < 1$ . In addition, to compare the results between Experiment 1 and Experiment 2 directly, a 2x4 mixed ANOVA was carried out with context (context-change, no-change) as within-subjects factor and mood (positive, neutral, negative, control) as between-subjects factor. No significant main effects of context or of mood on List 1 recall were found, both  $F$ 's  $< 1$ , nor was any significant interaction between context and mood,  $F(3,92) = 1.41, p = .25, \eta^2 = .04$ .

**List 2 recall.** Separate analysis of List 2 recall for Experiment 2 showed no significant effect of context,  $F(1,23) < 1$ . Comparison between Experiment 1 and Experiment 2 using a 2x4 mixed ANOVA with context (context-change, no-change) as within-subjects factor and mood (positive, neutral, negative, control) as between-subjects factor also revealed no significant main effects of context or of mood, nor any significant interaction between the two factors, all  $F$ 's  $< 1$ .

**Intrusion errors.** The mean amount of intrusion errors in Experiment 2 was below 5%. No effect of context on the amount of intrusion errors was found for either List 1 or List 2 intrusions, both  $F$ 's  $< 1$ .

**Order effects.** To investigate possible order effects, two mixed ANOVAs were carried out on List 1 and List 2 recall separately, with context (context-change, no-change) as within-subjects factor and order (context-change first, no-change first) as between-subjects factor. A significant main effect of order was found for List 1 recall,  $F(1,22) = 5.76, p < .05, \eta^2 = .21$ . No other significant main effects or interactions were found. The recall rates for List 1 in Experiment 2 according to order are presented in table 8.



Independent sample t-tests comparing the List 1 recall results for each order were then performed. This revealed that participants in the context-change first condition remembered more List 1 words under the no-change condition than participants in the no-change first condition ( $M = .59$ ,  $SD = .21$ , and  $M = .38$ ,  $SD = .22$ , respectively),  $t(22) = 2.49$ ,  $p < .05$ . There was also a tendency for the participants in the context-change first condition to remember more List 1 words than the participants in the no-change first condition under the context-change condition ( $M = .58$ ,  $SD = .18$  and  $M = .41$ ,  $SD = .25$ ), however, this difference was not significant,  $t(22) = 1.83$ ,  $p = .08$ .

### Discussion

Again, no effects of context on the amount of words remembered were found. For some reason, the context manipulation did not lead to the expected costs and benefits. The only significant effect that was found was a main effect of order, indicating that participants who started with the context-change condition had a tendency to remember more words from List 1 in both parts of the experiment. This order effect is different from the one found in Experiment 1 and cannot be interpreted as a learning effect. Otherwise, Experiment 2 replicated the findings from Experiment 1 when it comes to mood – participants had similar scores on the Affect Grid without a mood manipulation as in the neutral and the positive group in Experiment 1.

### General discussion

In two experiments, with a total of 96 participants, no effects of a context change on memory were found. Nor were any effects of the mood induction in Experiment 1 evident in the recall data. These findings were not consistent with the hypotheses and as such they were quite surprising.

The fact that the mood induction in Experiment 1 did not seem to influence memory, could indicate that the mood induction was ineffective. While participants in the negative condition reported significantly lower mood on the Affect Grid than participants in all other conditions, the participants in the positive condition did not report more elated mood than participants in the two neutral conditions. There were no significant differences between the mood groups on the PANAS. Thus, there is no reason to believe that the failure to observe an effect of the positive mood induction is due to the usual affective state of the participants in the positive mood group being more negative or less positive than the other groups.

In a review of mood inductions (Westermann, Spies, Stahl, & Hesse, 1996) it was found that negative mood inductions are generally more effective than positive mood inductions. One reason for this, the reviewers suggest, is that participants are usually in a reasonably good mood when starting an experiment, and it is easier to depress this mood than to enhance it further. This could also have been the case in the present experiments – the student participants were possibly in a quite good mood, and hence, the negative mood induction had an observable effect, while the positive mood induction did not lead to a more elated mood for the participants.

Mood inductions are also found to be more effective when participants are instructed explicitly that they should try to enter the specified mood state (Westermann, et al., 1996). However, such explicit instructions might lead to demand characteristics – participants are not really achieving the induced mood state, they are simply behaving as they believe they would if they were in the mood state that the experimenter wants them to achieve. This is a serious problem for the validity of mood inductions, and in the present experiments it was therefore decided not to instruct participants in this way. Still, instructing participants to enter the mood state that the images conveyed rather than simply to attend to them, might have led to pronounced differences between the neutral and positive mood conditions in the present experiments.

Even though no effects of the positive mood induction was observed on the Affect Grid, the effects of positive mood in studies using a similar mood induction procedure (Bäuml & Kuhbandner, 2009; Schmitz, De Rosa, & Anderson, 2009) gives reason to believe that this is an effective way to change people's moods. There is a possibility that the positive mood induction functioned as it was supposed to, but that it was hard to observe this effect because of the delay between mood induction and mood measurement. This is in line with studies showing that the effects of such mood induction procedures have quite short temporal duration, and that even though effects can be observed right after the mood induction, they fade after completion of a cognitive task (Eich & Metcalfe, 1989).

All in all, no firm conclusion about the effectiveness of the mood induction can be drawn from these results. But if we assume that both the positive and the negative mood induction was effective, why then did the mood of the participants not influence their recall performance? One could speculate that mood does not influence context-dependent memory, and that unlike retrieval-induced forgetting (Bäuml & Kuhbandner, 2007), directed forgetting (Bäuml & Kuhbandner, 2009) and the false memory effect (Storbeck & Clore, 2005), this is one memory phenomenon that does not vary with affective state. Another interpretation is that

mood acted as a context, as shown in studies on mood-dependent memory (Ellis & Moore, 1999). It could be reasoned that List 1 was encoded in a relatively neutral mood, while List 2 was encoded in a negative or positive mood. The mood could then have acted as a stronger contextual cue for the participants than the internal context change. As mood was changed in both the context-change and the no-change condition, no effects of the context condition would be evident. However, these are highly speculative interpretations that rest upon the assumption of finding normal context-dependent memory effects in the neutral conditions. The lack of effects of a context change in the neutral condition in both Experiment 1 and Experiment 2, does not allow any such interpretations of the other conditions.

The main question that must be discussed here then, is why no context-dependent costs or benefits were found in the neutral conditions. In Experiment 1, mood induction pictures were presented after the context change and the distraction task. Presenting pictures has not been done in combination with an internal context change before, and therefore, as already mentioned, it was thought that there was a possibility that viewing the pictures could lead to a context change for the participants. This possibility was addressed in Experiment 2, and the results argue against the pictures disturbing the effect. It would also have been desirable to run a control condition where participants were shown neutral pictures in place of the internal context change task in the context-change condition. If viewing the pictures leads to a context change, then List 1 costs and List 2 benefits should be found when comparing such a picture context-change condition with the normal no-change condition. Unfortunately, due to time limitations, this control experiment was not possible to perform.

Both experiments reported here have in common that they include some additional task after the internal context change and no-change distraction task. It might be speculated that this additional task, be it viewing pictures or counting backwards, could disrupt the effect. In the no-change condition, an additional task could lead to a context change in what is supposed to be a control condition. Even though the possibility that the pictures lead to a context change was weakened by Experiment 2, there is still the question of time. The time between List 1 and List 2 encoding is 105 seconds in the no-change condition, as compared to 45 seconds in most studies in the context-change paradigm. This might be enough time that contextual elements fluctuate to a state dissimilar from List 1. Alternatively, the distraction task in the no-change condition in Experiment 2, backwards counting for 105 seconds, might have been too demanding for the participants. Although no formal observations were made, participants seemed to make more mistakes than when the distraction task was shorter, and several participants reported that this was a hard task when they were finished with the

experiment. So, it might be that the pictures did lead to a context change in the no-change condition in Experiment 1, and that the long distraction task did the same in Experiment 2.

The additional task might also have disturbed the effect of the internal context change in the context-change condition. For instance, for an internal context change to be efficient, it might be necessary to start encoding of List 2 immediately after the context-change procedure is completed. One could imagine that participants normally encode List 2 into a “childhood home-context”, but that this clear context fades when List 2 encoding is delayed. With the additional task, the contextual elements might fluctuate towards a state more similar to the one present during List 1 encoding, and no context-dependent costs or benefits would be evident. This interpretation is in line with studies indicating that List 2 encoding plays an important role for context effects to appear in this paradigm (Pastötter & Bäuml, 2007; Pastötter, et al., 2008).

Of course, it is also conceivable that the context-change task simply did not function as it was supposed to. In a meta-analysis of studies on environmental context-dependent memory (Smith & Vela, 2001), it was established that effects of context on memory are less likely to occur when the environment is suppressed, either during encoding or during retrieval. Normally, environmental contextual features are encoded in memory. However, subjects might not encode the environment if they are focusing more on the material to be remembered. For instance, if participants are trying to form inter-item associations during encoding, they might as a consequence exclude the immediate environment (the context). This context suppression during encoding is called overshadowing. Outshining, on the other hand, is the name for what happens when the environment is suppressed during retrieval. Participants might, for instance, use inter-item associations as cues during retrieval, even though contextual cues were encoded. It should be clear that if overshadowing or outshining occurs, it is less likely that a change of context will affect memory. In the same meta-analysis (Smith & Vela, 2001), it was also found that the effect of a context change will decrease if participants at test mentally reinstate the context that was present during learning. So, in the present experiments, participants might have used a strategy of forming inter-item associations during encoding, or of using associative cues during retrieval, or they might have been able to mentally reinstate the context that was present during List 1 encoding. Why the participants in the present experiments should have done this to a greater degree than participants in other experiments showing clear effects of similar context-change procedures, is unclear.

If overshadowing, outshining or mental reinstatement of context did not occur, there is still a chance that the context manipulation was too weak. The meta-analysis by Smith & Vela (2001) showed that although context has a reliable effect on memory performance, the average weighted effect size across all studies is modest ( $d = .28$ ), and in some studies no effect is found (Fernandez & Glenberg, 1985; Saufle, et al., 1985). Even though this concerns environmental context effects, it should also be relevant for internal context manipulations. The implication is that studies of context-dependent memory should take care to use procedures that induce clear, strong changes in context. The importance of this point was demonstrated in a recent study that used an internal context change procedure where participants were told to either imagine going through their present home or through their parents' home (Delaney, et al., 2010). It was reasoned that the context change would be greater if participants imagined their parents' home than if they imagined their own. And indeed, significant context-dependent costs was only found when participants imagined their parents' home, and also, the amount of context-dependent costs varied with the amount of time since the participants visited their parents' home. In the present experiments, participants were instructed to imagine their childhood homes, and the success of previous experiments using this task gave reason to believe that this would induce a clear change in context. Still, some of the participants might have visited their childhood homes recently, and this could have led to a less clear change in context. In future studies, this possibility could be controlled by asking participants about how long it is since their last visit to the place they are instructed to imagine and describe.

Another interesting option for future studies is to use a new context manipulation procedure introduced in a recent study (Smith & Manzano, 2010). In this study, the words to be remembered were presented superimposed over videos of real environments, and then recall was cued using the same videos. The videos were perceptually rich and contained actions, movements and sounds, and very large effect sizes were found for this context manipulation. It would be interesting to combine this method of manipulating context with a mood induction – it might be that this would produce more reliable and clear results.

In both Experiment 1 and Experiment 2, the only significant effects that were found in the recall data were order effects. The interaction between order and mood for List 1 recall in Experiment 1 reflected a complex pattern of results. The positive mood participants remembered more List 1 words in the no-change than in the context-change condition when they started with the context-change condition, while the neutral and negative participants did not show this pattern. When participants started with the no-change condition, participants in

neutral and negative mood remembered more List 1 words in the context-change than in the no-change condition, while participants in positive mood did not show this pattern. This means then, that participants in neutral and negative mood showed a “learning effect” for List 1 only when they started with the no-change condition, while participants in positive mood showed a learning effect only when they started with the context-change condition.

The main effect of order on List 1 recall found in Experiment 2 reflected that participants who started with the context-change condition remembered more List 1 words in the no-change condition than participants who started with the no-change condition. A tendency was also found for the participants who started with the context-change condition to remember more List 1 words in the context-change condition.

There are no obvious theoretical reasons why the pattern found in the order/mood interaction in Experiment 1 should occur, and for Experiment 2, it is peculiar that starting with the context-change condition should give an advantage in remembering List 1 words. It seems likely that these interactions are coincidences. At least, these results should be interpreted with caution, as they are based on comparing groups of 12 participants.

The interaction between context and order in Experiment 1 is seemingly more easily explained. The results showed that participants performed better on both List 1 and List 2 in what was for them the second part of the experiment. Participants who started with the context-change condition remembered more words in the no-change condition, and vice versa. This could be seen as a learning effect, and could indicate that the two conditions were more or less equivalent. Even though Experiment 2 weakened the interpretation that the pictures led to a context change, it still seems plausible that the participants experienced the two context conditions as quite similar, and that they learned how to memorize the words during the experiment.

A comment should also be made on the relation between the context-change and directed forgetting paradigms. Part of the goal of this investigation was to see whether affective state influenced context-dependent memory in the same way as directed forgetting. No such conclusion can be drawn from the present data because of the lack of context effects in the neutral conditions. However, the present results do not seem to strengthen the theory that a change in mental context is the sole explanation for the usual directed forgetting findings. The directed forgetting effect was stable in the neutral condition in Bäuml & Kuhbandner’s (2009) experiment on mood and directed forgetting, which was highly similar to the present experiment. This might indicate that retrieval inhibition is the mechanism behind directed forgetting: the goal of forgetting List 1 is kept active during the presentation

of neutral and negative pictures, and is accomplished during the presentation of List 2. The results are also consistent with the proposed view that the directed forgetting paradigm reflects an inhibitory context-change, while the context-change paradigm reflects a non-inhibitory context-change. But although it is tempting to interpret the results in this way, it is problematic to use the results from the present experiments to comment upon such theoretical issues, as there are many possible sources of error that need to be addressed. A study which directly compares the two paradigms when they are combined with a mood induction would help to resolve these issues.

All in all, these two experiments seem to raise more questions than they answer. The failure to find the usual context-dependent memory effects in the neutral conditions, leaves the question of whether affective state influences context-dependent memory open. As a consequence, it is also impossible to say whether mood influences cognitive processing in specific ways (Clore & Huntsinger, 2007) or if it acts more like a context in this paradigm (Ellis & Moore, 1999). Finding no context-dependent memory effects could indicate that small variations in experimental procedure in the context-change paradigm might disrupt the effect. On the one hand, this could give some valuable information about how context effects occur. For example, if as proposed List 2 encoding needs to start immediately after the context change, this strengthens the studies that emphasize the role of List 2 encoding for context effects (Pastötter & Bäuml, 2007; Pastötter, et al., 2008). On the other hand, overshadowing, outshining or mental reinstatement might have occurred, or the context manipulation might have been too weak (Smith & Vela, 2001). These different possibilities could be investigated in future studies. Whichever of these possibilities that are pursued, future studies should take care in using as strong manipulations of internal context as possible.

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### Appendix

The lists of words used for the experiment, with English translations:

<b><u>List 1</u></b>	<b><u>List 2</u></b>	<b><u>List 3</u></b>	<b><u>List 4</u></b>
Helm (Helmet)	Lupe (Magnifying glass)	Herd (Stove/Cooker)	Seil (Rope)
Löwe (Lion)	Welle (Wave)	Kalb (Calf)	Sieb (Sieve)
Wolle (Wool)	Blei (Lead)	Rock (Skirt)	Dose (Box/Can)
Stube (Room/Living room)	Deckel (Lid/Top)	Büro (Office)	Huhn (Chicken)
Schuh (Shoe)	Pille (Pill)	Kiste (Case/Crate)	Eisen (Iron)
Himmel (Sky)	Kugel (Globe/Orb/Sphere)	Bogen (Bow)	Lippe (Lip)
Scherbe (Broken fragment, broken piece of glass)	Mantel (Coat)	Kette (Chain)	Daumen (Thumb)
Fischer (Fisherman)	Zunge (Tongue)	Lokal (Pub/Bar)	Forelle (Trout)
Kamm (Comb)	Butter (Butter)	Hammer (Hammer)	Dampfer (Steamboat)
Distel (Thistle)	Planet (Planet)	Tasche (Purse/Bag)	Vorhang (Curtain)
Mehl (Flour)	Fahrer (Driver)	Heizung (Heater)	Rüstung (Armor)
Ball (Ball)	Märchen (Fairy tale)	Schrank (Closet)	Wunde (Wound)
Stern (Star)	Flieger (Pilot/Aviator)	Schild (Sign)	Käufer (Shopper)
Brust (Chest)	Wurm (Worm)	Pfleger (Caregiver)	Rentner (Pensioner)
Stute (Mare)	Tüte (Bag)	Schlamm (Mud)	Feier (Celebration)
Radio (Radio)	Wald (Forest)	Dichter (Poet)	Rektor (Headmaster)
Balkon (Balcony)	Wurst (Sausage)	Dieb (Thief)	Gipfel (Peak)
Messer (Knife)	Hafen (Harbor/Port)	Oper (Opera)	Weste (Vest)
Schmuck (Jewelry)	Gattin (Wife)	Kunde (Customer)	Gewicht (Weight)
Elefant (Elephant)	Stuhl (Chair)	Pächter (Leaseholder)	Verkehr (Traffic)

Table 1

*Mean recall rates (with standard deviations in brackets) for List 1*

<b>Mood</b>	Context-change	No-change
Positive	.44 (.18)	.48 (.23)
Neutral	.56 (.21)	.49 (.23)
Negative	.56 (.22)	.54 (.18)

Table 2

*Mean recall rates (with standard deviations in brackets) for List 2*

<b>Mood</b>	Context-change	No-change
Positive	.46 (.25)	.50 (.31)
Neutral	.52 (.21)	.45 (.25)
Negative	.54 (.23)	.50 (.22)

Table 3

*Order/mood interaction – mean recall rates (with standard deviations in brackets) for List 1 in the context-change first order*

<b>Mood</b>	Context-change	No-change
Positive	.43 (.18)	.53 (.26)
Neutral	.55 (.26)	.59 (.24)
Negative	.44 (.19)	.50 (.20)

Table 4

*Order/mood interaction – mean recall rates (with standard deviations in brackets) for List 1 in the no-change first order*

<b>Mood</b>	Context-change	No-change
Positive	.45 (.19)	.43 (.19)
Neutral	.57 (.14)	.38 (.18)
Negative	.67 (.20)	.58 (.14)

Table 5

*Context/order interaction – mean recall rates (with standard deviations in brackets) for List 1 independent of mood*

<b>Order</b>	Context-change	No-change
Context-change first	.47 (.22)	.54 (.23)
No-change first	.57 (.19)	.46 (.19)

Table 6

*Context/order interaction – mean recall rates (with standard deviations in brackets) for List 2 independent of mood*

<b>Order</b>	Context-change	No-change
Context-change first	.45 (.23)	.54 (.27)
No-change first	.56 (.23)	.42 (.24)

Table 7

*Mean recall rates (with standard deviations in brackets) for List 1 and List 2 in Experiment 2*

<b>List</b>	Context-change	No-change
List 1	.49 (.23)	.48 (.24)
List 2	.56 (.20)	.55 (.27)

Table 8

*Order effect – mean recall rates (with standard deviations in brackets) for List 1 in Experiment 2*

<b>Order</b>	Context-change	No-change
Context-change first	.58 (.18)	.59 (.21)
No-change first	.41 (.25)	.38 (.22)